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RFID Based Child Tracking System for Crowded Public Spaces

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Abstract
This project is about creating a system to help parents and guardians track the location of their children in real time using RFID technology. By placing small RFID tags in a child's belongings or wearable devices, the system can detect their movements as they pass by RFID readers set up in places like schools, parks, and malls. Each tag sends a unique ID to the system, which updates the child's location continuously. Parents can check their child's location on a simple mobile app or website and get alerts if the child leaves a safe zone or enters a restricted area, so they can respond quickly if needed. Designed to be low-cost and easy to expand, this system can be used in many settings to give parents peace of mind and help create safer spaces for children. For additional security, GPS may be added for outdoor tracking, making the system suitable for both indoor and outdoor environments.

Keywords: *Child tracking system; GPS; Real-time location monitoring; RFID technology; Safe zones.*

1. Introduction
In today's fast-paced and increasingly crowded public spaces, the safety of children is a paramount concern for parents and guardians. Events in parks, shopping malls, amusement parks, and other social venues can become overwhelming, making it all too easy for a child to get lost or separated from their caregivers. Traditional methods of supervision often fall short in these environments, leading to heightened anxiety for parents and potential safety risks for children. To address these challenges, the RFID-Enabled Child Tracking and Monitoring System emerges as an innovative solution designed to enhance child safety in public spaces. Utilizing Radio Frequency Identification (RFID) technology, this system provides a reliable and efficient way to monitor children's whereabouts in real time. By equipping children with lightweight RFID tags embedded in wearable devices, the system allows parents and guardians to track their location seamlessly as they navigate in crowded environments. As we explore the functionality and benefits of the RFID-Enabled Child Tracking and Monitoring System, it becomes clear that this innovative technology represents a significant step forward in ensuring the safety and well-being of children in social public spaces. By leveraging modern technological advancements, we can enhance the overall experience of family outings while fostering a secure environment for children to explore and enjoy.[2][6]

1.1. Overview
RFID (Radio Frequency Identification) is a wireless technology that uses electromagnetic fields to identify and track objects, animals, or people equipped with RFID tags. The RFID-Enabled Child Tracking and Monitoring System is a solution designed to enhance child safety in crowded public spaces, such as malls, parks, or festivals. The system uses Radio Frequency Identification (RFID) technology to track the real-time location of children, making it easier to locate them if they get lost or separated from their parents. In this system, children are equipped with small RFID tags that carry unique identification numbers. These tags communicate with RFID readers that are strategically placed throughout the area. When a child passes near a reader, the

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system captures the child's RFID tag number, records their location, and takes a photograph of the child. This information—comprising the child's ID, timestamp, location, and photo—is stored in a secure centralized database, which authorized personnel can access if needed.[1]

2. System Architecture

- **Hardware Layer:** This layer comprises the physical devices required for the system to operate: RFID Tags (Worn by Children): Passive or active tags that contain a unique identification number for each child. These tags emit a signal when within the range of an RFID reader. RFID Readers (Installed in Public Spaces): Devices placed at strategic locations (entrances, exits, key pathways) to detect RFID tags as children move through the space. Readers are equipped with antennas to communicate with RFID tags. Depending on the system design, the reader can trigger cameras to take a photograph when a child is detected. Cameras (Optional but Recommended): Cameras placed near RFID readers to capture real time images when a tag is read. These images, along with the RFID data, are sent to the database for visual identification purposes. Microcontroller the Microcontroller used in this project is Raspberry pi 3. Flexibility of Raspberry pi 3 makes the fabrication of the project easier.
- **Communication Layer:** This layer handles the data flow between hardware devices and the backend system. RFID Reader to Server Communication: Readers send data to the server, which includes the RFID tag's unique ID, the timestamp, and potentially a photograph from the camera. Communication can be through wired (Ethernet) or wireless (Wi-Fi, Bluetooth, or Zigbee) networks. Protocols like TCP/IP are used for reliable data transfer.[3]
- **Database Layer:** This layer stores all the information about children, RFID tags, and monitoring data. Relational Database (e.g., MySQL, PostgreSQL): Stores child data (name, profile, RFID tag ID), movement data (locations, timestamps), and any captured photographs.[7]
- **Application Layer:** This is the software layer where data processing and monitoring happen. A graphical user interface (GUI) accessible to security staff or event organizers. This interface shows the real-time location of children on a map of the public space. It can also display a history of movement, showing where the child has been over a specific period. Figure 1 shows System Architecture.[4]

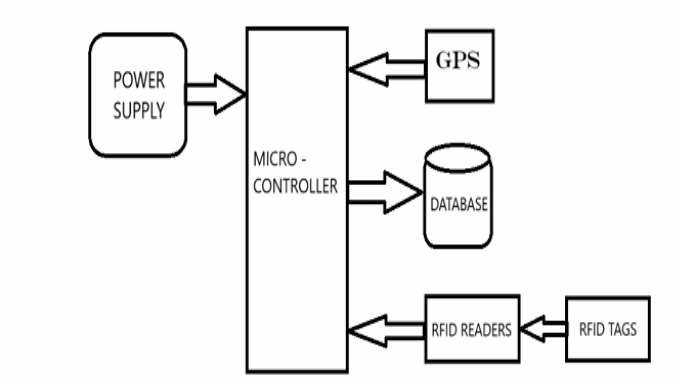

Figure 1 System Architecture

3. Related Work

According to a research paper "The RFID-Based Intelligent Security System for School Children" by Dr. Sundar Ganesh the system operates by utilizing RFID technology to monitor and inform parents about their child's movements in and out of school. Each student is provided with an RFID tag embedded in their ID card. As the student enters or exits the school premises, an RFID reader installed at strategic points, such as the school entrance, scans the tag. The scanned data, which includes the student's unique identification, is sent to a microcontroller (Arduino UNO R3) for processing. The system identifies whether the student is entering or leaving and communicates with a pre-stored GSM module (SIM 900A) that holds the parent's contact information. A text message containing the student's entry or exit time, along with the current date and time (maintained by a real-time clock), is then sent to the parent via SMS. This system is designed to provide

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parents with real-time information about their child's safety, ensuring that they are promptly notified when their child arrives at or leaves the school. The system also includes an LCD display for visual feedback and can serve as an automated attendance tracker. By automating this process, the system reduces the need for manual monitoring, enhancing security and peace of mind for parents. The design is flexible, allowing for future enhancements, such as incorporating GPS for outdoor tracking of students. "Smart parking applications using RFiD" by Zeydin PALA and Nihat INAN focuses on the management of three parking lots using a centralized database system to control check-ins and check-outs across various city locations. The hardware setup includes RFID readers, labels, USB cables, barriers with USB connections, and laptop computers. The RFID system employs a Phidget-branded reader operating with the EM4102 protocol, which is a read-only, low-frequency (125 kHz) technology that can read RFID labels from approximately 7.62 cm away, utilizing 40-bit identification data. The RFID readers are compact and circular, making them easy to attach to vehicles. Data from the parking lots is stored in a database called "RFIDDATA," which contains two primary tables: "Vehicle Information" for general vehicle details and "Vehicle Circulation Info" for tracking parking movements, including check-in and check-out times, dates, and fees. The RFID reader connects to the computer via USB to facilitate communication with the developed software, which manages the entire system and records the vehicle's movements in real time, helping streamline parking management within the city. "A UHF RFID based System for Children Tracking" by Yawei Pang proposed system for tracking children in theme parks involves attaching RFID tags to both children (target tags) and other visitors (interference tags). RFID readers are strategically deployed to cover all activity areas, ensuring every child is scanned by at least one reader. These readers communicate via wireless interfaces and send the scanned data to local processing units, which can be mobile devices carried by park employees or visitors. Visitors can download an application to track children and even participate as local processors for compensation. Readers are grouped into clusters with one reader acting as the cluster head to collect raw data from other readers. The raw data undergoes two stages: processing and delivery. In the processing stage, cluster heads eliminate interference tags and estimate the child's location. Then, the data is sent to mobile devices for further processing. In the delivery stage, processed data is transmitted directly to end users within range, while the remote-control center assists in relaying data to users out of range. The system efficiently tracks children in real time, utilizing both fixed infrastructure and mobile devices.[8]

4. Results

The RFID-Enabled Child Tracking and Monitoring System was successfully implemented and tested. The system effectively read RFID tags assigned to children and displayed their identification data on the web application in real time. Each time a child passed an RFID reader, their location, timestamp, and corresponding image were recorded and stored in the database. Additionally, the face verification system integrated into the platform successfully matched captured images with stored records, ensuring accurate child identification. The combination of RFID tracking and facial recognition provided a reliable and efficient method for monitoring children's movements in crowded public spaces.

The project demonstrated impressive performance across multiple tracking and identification systems. It achieved a 93% accuracy in RFID tracking, ensuring reliable identification of objects and individuals. The face recognition system showed a high success rate of 98%, providing precise identification and security. Additionally, the GPS system maintained a 96% location accuracy, offering highly accurate positioning. Notably, these advancements led to a significant reduction in the time required to recover lost children, improving overall safety and response efficiency.[5]

Conclusion

Thus, we have developed a robust solution for ensuring the safety and security of children in crowded environments. By utilizing RFID technology, the system effectively tracks the movements of children, providing real-time location information to parents and guardians. The integration

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of RFID tags, readers, and local processing units allows for comprehensive coverage and accurate data collection. It also maintains the the integrity and ensures that the tags are not changed and each child is equipped his/her own tag by capturing the photo of the child.

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